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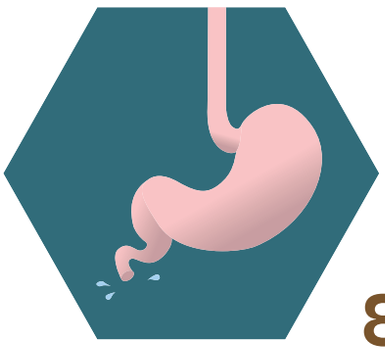

The BODIES we live in

are nothing short of marvels of engineering, biology and chemistry. Working to discover even just a fraction of how they work — and why they sometimes don't work as they should — can consume a researcher's entire career and still produce few, if any, "Eureka" moments. But scientists keep questioning and searching, some of them with support from the Utah Agricultural Experiment Station. We feature a few of them in this issue whose research is related to food and nutrition though genetics, environment and economics also get into the mix.

Nutrition is one of our most basic needs and also one of the most complicated. It used to be that people had to spend most of their time finding enough food to sustain themselves. In some places that is still the case. But in more affluent societies it seems now that many of our health problems are largely the result of easy access to too much food, and especially the sort of food that is the worst for us.

It's great for Americans that on the whole we spend a lower percentage of our income on food than people anywhere else in the world (World Bank), but our relationships with food are not as simple as just managing to eat something that provides our bodies with nutrients. If nutrition were that straightforward we could all just eat a little cube nutrients as "breakfast" or "dinner" like characters in a sci fi movie and be done with it. I can't imagine that being a satisfactory experience anywhere but on some outpost halfway to another galaxy. Among my friends and family members there isn't anyone (determined by a highly unscientific poll) who would choose to eat that way. There may be some people who think of food only as energy and who would be happy to slow down just long enough to swallow their daily cubes or capsules, but they are not my friends.

For good or bad, driven by tradition or just clever marketing, many of our social interactions involve food. We celebrate with cake, gather for barbecues, and send our teenagers to pizza parties. Even our speech is peppered with references to food. We do our jobs so we can bring home the bacon and work for the big cheese who we hope is not a bad egg. A simple task is a piece of cake though sometimes we have to butter someone up while trying to remain cool as a cucumber.

There are many things we don't know about how nature and nurture shape our eating habits, and how our eating habits shape us. There are easily just as many things we don't know for certain about the complexities of nutrition, metabolism, and human development so it's important to keep searching for answers to questions about one of our most fundamental needs. While the research goes on though, it's a good idea to heed some of the advice we've heard for a long time because it has proven true: practice moderation in all things, don't smoke, and eat your vegetables. –LH

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UtahState University

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UTAH'S CONNECTION TO Cleft Palate

The faces

in advertisements for the charities Operation Smile and The Smile Train are familiar to most Americans. The photographs show sad children whose faces are marked by cleft lips, sometimes even gaping openings between their mouths and noses that reveal misshapen palates and teeth that have grown askew. The "after" pictures show their surgically reconstructed smiles and beaming faces. We tend to think of them as the people who have cleft lip and cleft palate: poor and living in places like India, Guatemala, Rwanda or the Philippines.

Ron Munger — who has devoted much of his career in nutritional epidemiology to deciphering the causes of cleft lip and cleft palate — has spent time in several distant, developing nations. It turns out though that he has a large pool of prospective research subjects here at home. Utah has the highest recorded incidence of cleft lip and palate in the United States: 2.2 per 1,000 births, which is about double the average for Caucasian Americans and equal to the numbers in the Philippines.

Photo: Gary Neuenswander

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"It could be that rates are higher and just underreported in the Philippines, but we're trying to understand why the numbers of recorded cases here are so similar," Munger said. "I thought clefts occurred at higher rates in developing countries because of poverty and poor nutrition and those are likely to be important causes. But why are the numbers so high in Utah? That remains a mystery. Smoking is associated with clefts, but smoking rates are fairly low in Utah. Diabetes and obesity have been associated with clefts, but Utah is about average nationally in rates of diabetes and obesity. Utah mothers are, in general, well-educated and have far more resources than mothers in the Philippines, so we don't understand why the rates in Utah are so high."

Most people in the U.S. are less aware of cleft birth defects compared to those living in developing countries because clefts here are surgically repaired soon after birth. In Utah we don't live near children with unrepaired clefts who struggle to eat, drink or speak because of cleft lips and palates or people who have grown to adulthood on the fringes of their communities because of their appearance. But the birth defect affects people everywhere and if Munger and his colleagues can discover the cause — or causes — thousands of surgeries on infants could be avoided each year.

During gestation, everyone begins with a cleft lip that typically closes between 6 and 8 weeks of fetal development. The palate follows, closing at 10 to 12 weeks. When they don't close normally, the cleft remains. The causes of cleft lip and palate (CLP) are somewhat less mysterious than they were just a few decades ago. Scientists know maternal health, nutrition, genetics, and the environment are crucial parts of the puzzle. But each factor is complex on its own and understanding how each may be implicated in CLP means investigating them all and their interactions.

There are themes Munger's research follows whether he is examining data from Utah or abroad. One is focused on nutrients in mothers' diets. Another is whether mothers of children with CLP are more prone to developing diabetes or metabolic syndrome, a collection of metabolic disorders that includes a large waistline, high triglyceride level (a type of fat in the blood), low HDL "good" cholesterol level, high blood pressure and a high fasting level of blood sugar that can lead to diabetes, heart disease and stroke. A third area of interest is the possible connection to poor air quality.

Three nutrients are known to be related to CLPs and neural tube defects, which are birth defects of the brain, spine or spinal cord. Folate, vitamin B6 and zinc are all important to fetal development. A successful clinical trial that demonstrated folic acid supplements reduced the risk of neural tube defects led the U.S. Food and Drug Administration to mandate in 1998 that folic acid be added to flour. The ruling was a reaction to evidence from that study and the fact that birth defects occur so early in pregnancy that most expectant mothers are not taking prenatal vitamins during that critical stage of development. Munger said there is some indirect evidence that problems with folate nutrition may be at play in causing CLP.

He read of studies in Mexico, published the in medical journal The Lancet in the 1970s, that reported on tracking the health of

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IN UTAH, BUT RON MUNGER'S RESEARCH GOES FA

tah's sporadically bad air quality
d to the state's high incidence of children born with clefts?

women up to 30 years after they had given birth to babies with and without CLP. The mothers of cleft children developed diabetes at a much higher rate than mothers of unaffected children, but this difference between mothers was not apparent at the time they gave birth. Among the things Munger is examining is how blood folate levels change over time for women with and without cleft children. He has found some evidence that mothers of cleft children have increasingly lower blood folate levels over time, and suggests that this may be evidence of progressive metabolic disorder in folate metabolism, much like the Mexican mothers of cleft children who had progressively higher rates of another metabolic disorder—diabetes. With funding from the Centers for Disease Control and Prevention, Munger and colleagues from the Utah Birth Defects Network (Utah Department of Health) and the University of Utah are re-contacting mothers in Utah from their previous studies to gather more data on folate metabolism, diabetes, and metabolic syndrome.

Munger is also working with colleagues in India and the Philippines on pilot studies funded by the U.S. National Institutes of Health to conduct similar studies of maternal nutrition and metabolic disorders that may be linked to clefts, work that will include surgeons and other staff with Operation Smile and Smile Train.

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R BEYOND THE STATE'S BORDERS.

Photos Courtesy of Ron Munger

"We know maternal health matters," Munger said. "Compared to normal weight mothers, an underweight mother's risk of having a baby with a cleft is twenty percent higher and seventeen percent higher for obese mothers."

Munger said based on work he and his colleagues have already done, it appears that a mother's whole dietary pattern is more strongly associated with the risk of having a child with a cleft than intake of any single nutrient. When asked about whether they took vitamins for the two months prior to becoming pregnant, twenty-five percent of women in the Utah study reported planning ahead and taking them.

"About half of women don't know they are pregnant until the second month, so at that point the number of vitamin takers jumps to about fifty percent," Munger said. "By the third and fourth months the number jumps again. But comparing vitamin intake at different times during pregnancy between mothers of children with clefts and without, showed no difference that we can detect in the Utah sample. However, a combination of taking prenatal vitamins and eating the DASH (Dietary Approaches to Stop Hypertension) diet shows about a fifty percent reduction of risk for clefts. The DASH diet includes an abundance of fruits and vegetables, whole grains, low-fat dairy products, and low intake of red meat and salt."

His international work brought to Munger's attention the possibility of links between poor air quality and CLP. The incidence of children born with CLP is high in rural Asia and women there have among the world's highest rates of lung disease, including lung cancer and chronic obstructive pulmonary disease (COPD), even if they are not tobacco smokers. It is also known that women who smoke have a forty percent increased risk of having a child with a cleft.

"Women in rural Asia are repeatedly exposed to cooking and heating fires in their homes," Munger said. "Indoor air pollution is a huge concern, as is outdoor air pollution."

Could Utah's sporadically bad air quality be linked to the state's high incidence of children born with clefts? That question prompted Munger's current efforts to collaborate with USU Toxicology Professor Roger Coulombe who studies the adverse effects small particulate air pollution have on human cells and tissues.

In the lab, Coulombe and his associates incubate human lung cells and then expose them to PM 2.5 particles (meaning the particles are just 2.5 microns in diameter) that have been collected from polluted air. These particles are beyond tiny. To put 2.5 microns in perspective it helps to know that the diameter of a human hair is typically 50-70 microns. These particles — which often become trapped for days or weeks during the winter in northern Utah's Cache Valley and along the state's populous Wasatch Front — drastically reduce visibility and can make it painful to breathe. PM 2.5s are also small enough to pass directly into the bloodstream and cause damage. Coulombe has found lung cells react rapidly to the particles, becoming inflamed and increasing production of C-reactive protein

Photos: Courtesy of Ron Munger

which is linked to inflammation throughout the body which is associated with cardiovascular disease and adverse effects on maternal and child health. Because smoking is an established risk factor for clefts, Munger believes that indoor and outdoor air pollution are also potential causal factors, though to date this has not been adequately studied. Munger is working to develop studies of air pollution and clefts in India, the Philippines and Utah.

Though genes are a dominant force in human development and there are known genetic defects that result in clusters of many children affected with clefts in families, these are fairly rare. Yet, many have wondered if Utah has some genetic "difference" that could explain the high numbers of children with clefts.

The genetic makeup of Utah's population is very well studied," Munger said. "It turns out Utah has a very diverse mix of Northern European ancestry because its Causcasian population was founded by a large number of immigrants from Scandanavia, Germany, and the British Isles. Utah's population was not founded by very small groups of people like the Amish or Mennonites, a situation that can result in a high frequency of deleterious genes. While some rare families have a high frequency of genes related to clefting, Munger believes that Utah's high rate of clefting is not linked to large-scale genetic differences but rather is related to factors of lifestyle and environment.

As it is with most research, a simple question like, "What causes cleft lip and cleft palate?" has no simple answer. What scientists learn leads to more questions and to more investigations of what we don't know. Though Munger knows discovering the roots of CLP will consume much of his attention, and that of other researchers even after he retires, he isn't looking for something easier to explore. He isn't a medical doctor, his work mostly involves detective work in interesting populations such as in India, the Philippines, and Utah. He works on deciphering mountains of data, and it is the experiences of seeing hundreds of faces of affected children, their families, and their living conditions that keeps him at it.

"I'm not a clinician," he said. "I don't do surgery and therefore I can't do anything to immediately change the lives of the children I study. I can however design studies to collect data and examine new ideas. You can't help but be motivated to find a way to help when you are there with these people and these problems are right in front of your eyes. You see how important this work could be to the children not yet born." –LH

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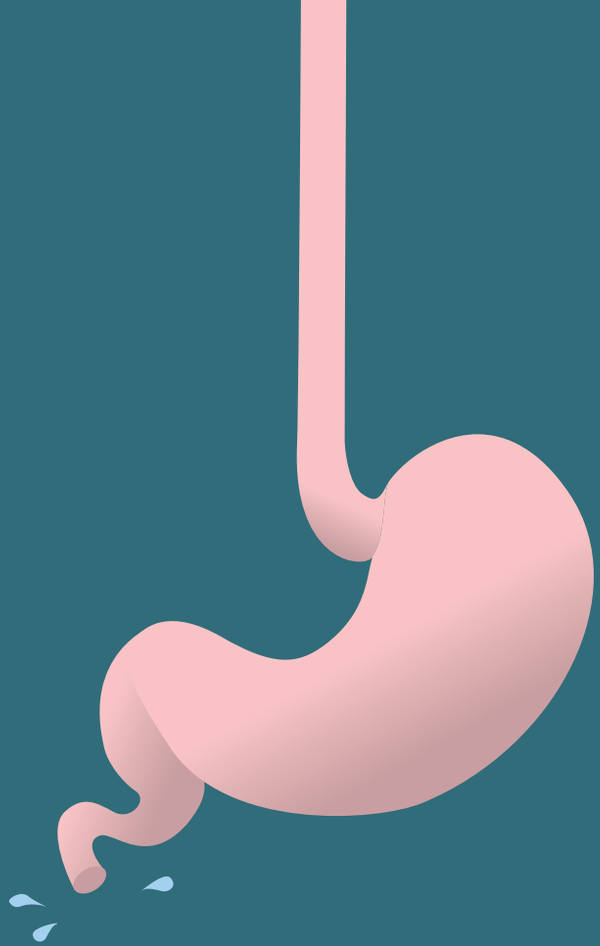
RON MUNGER'S SEARCH FOR THE CAUSES OF CLEFT LIP ATE CONTINUES TO TAKE HIM TO CLINICS IN INDIA AND THE PHILIPPINES.



LEAKY GUT

Nutrition Research: Science Goes Beyond Gut Instinct

If it's true that we humans are what we eat, then it's no wonder we are complicated creatures. Our diets are tangled webs of vitamins, fats, fibers, sugars, proteins and minerals, so teasing out the role (or roles) of each component can be difficult. Then combine that complexity with individual differences that affect humans, like genetics, the environment, metabolism rates, body composition, etc., and it's a daunting puzzle.

Robert Ward, an associate professor in Utah State University's Department of Nutrition, Dietetics and Food Sciences (NDFS), is among the scientists working to help sort the pieces of nutrition puzzles and provide insights that can help people make important food choices. He is especially interested in understanding what bioactive nutrients may be doing for and/or to our bodies. Bioactive nutrients are things you eat that are not essential in the diet, but that can make you healthier. For example, if you don't get enough vitamin C you'll get scurvy. Consuming bioactive nutrients, such as dietary fiber or certain phytochemicals, may make you healthier, but their absence won't result in disease. It can be challenging to discover scientifically if a bioactive has any effect and how it works as they are not, by definition, essential.

"It's hard to look at something like green tea and figure out how it's going to make you healthier," Ward said. "When we give somebody an essential nutrient we are trying to prevent disease. When we give somebody a bioactive we're trying to improve health. Health is very dynamic and something like green tea seems simple but it is a whole complex of chemicals and affects a lot of systems. So, in theory, you've got to look at everything that is interacting."

A further complication in seeking the sort of definitive results and recommendation people hope for from nutrition studies stems from the standardizing facets of the research. Solid science comes from having multiple scientists in multiple labs repeating an experiment and confirming or refuting the results of a previous one. When using animals in nutrition experiments, scientists typically feed them very specific diets. The American Institute of Nutrition recommends a specific feed for rodents in the lab which is purified and carefully balanced so that animals are well fed and every scientist and lab technician knows exactly what is in the feed.

"The diet is absolutely purified so you get the same results everywhere and that's very important," Ward said. "But in the United States people do not have an ideal diet. We took dietary records of people in the National Health and Nutrition Survey and translated the average intake of Americans into a mouse diet. We think that is a better model for looking at the effects of bioactive nutrients."

In one study, Ward and colleagues Korry Hintze, an assistant professor in NDFS, and graduate student Albert Zhou, studied the effects of a potential bioactive ingredient with a less-than-appetizing name: milk fat globule membrane. It is found in all dairy products to some extent, but is a natural byproduct of butter production. It is called buttermilk but should not be confused with buttermilk you buy at the grocery store, which is typically skim milk that has been processed to give it the characteristic buttery, tangy taste.

"We're working with a sort of classic churned buttermilk and there is a lot of anecdotal information that it's really good for you, but there's not a lot of data," Ward said. "We're intrigued by it because there is evidence that certain phospholipids [which it contains] may benefit the gut and that some of the molecules have anti-colon cancer activity."

Among the questions the researchers hope to answer is whether consuming milk fat globule membrane (MFGM) can improve the

Illustrations: Elizabeth Lord

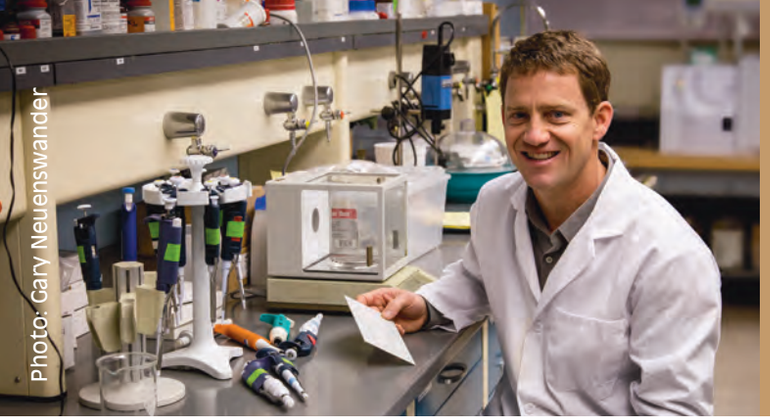


Photo: Gary Neuenswander

Robert Ward's goal is discovering the physiological and chemical changes that foods create.

structure of the gut. Leaky gut syndrome can be triggered by toxins, poor diet, parasites, infection or medication. Whatever the cause, the result is that the gut becomes abnormally permeable and allows microbes, toxins or waste to leak into parts of the body where they should not be and they trigger an immune response that causes inflammation. Among the substances that commonly escape from a leaky gut are lipopolysaccharides, relatively large molecules that are pieces of certain bacterial cells. Ward explained that if you were to take a small piece of the bacteria and inject it into your bloodstream you would almost instantly feel as though you had the flu and your immune system would ramp up in an effort to get rid of the infection.

People with metabolic syndrome — defined by a combination of health factors that increase risk for heart disease, type 2 diabetes and stroke — have high circulating levels of lipopolysaccharide in their blood that are likely caused by leaky gut. This causes chronic, systemic inflammation which, in turn, causes their immune system to be overly active. Ward said it has also been hypothesized that this condition can push people from pre-diabetes to type 2 diabetes. Factors that indicate metabolic syndrome include having a high body mass index (see sidebar), high waist circumference, high blood triglyceride levels, low HDL ("good cholesterol") levels, high blood pressure and consistent high blood glucose. Anyone with three of these factors could have the condition.

In one experiment aimed at determining if MFGM helps prevent leaky gut, the researchers formulated diets for mice with different sources of fat: One with corn oil and the other with anhydrous milk fat (which is almost pure milk fat made from butter or cream) supplemented with milk fat globule membrane (MFGM). Among their objectives was to determine whether or not MFGM would have an effect on the guts of mice that consumed it.

Mice were assigned to groups that were exclusively fed one of two diets for several weeks. The mice were then given lipopolysaccharide and their levels of gut leakiness were assessed. Ward and his colleagues found that gut permeability was measurably higher in mice that ate the control diet with corn oil in comparison with mice that ate the diet with MFGM. The MFGM-treated mice had lower inflammation responses to the lipopolysaccharide, likely due to improved gut structure and decreased permeability.

Will consuming MFGM benefit people by reducing occurrence of leaky gut and the inflammation it causes? The research team is beginning a study with humans in an effort to find out. Ward said the researchers are beginning by recruiting a group of test subjects who have metabolic syndrome. They will be given yogurt to eat every day for one month. Some participants will be eating a standard yogurt, others will eat the same kind of yogurt supplemented with 2-4 grams of MFGM, and a third group will eat a soy-based pudding with nutrients similar to the yogurt.

At the end of the study period, the participants will eat a common fast food breakfast of eggs and sausage on an English muffin and a side of hash browns. "It's about 900 calories," Ward said. "After they have eaten the breakfast we will draw blood every hour for five hours. In the blood samples we'll be looking for the absorption of lipopolysaccharide."

Ward added that there is some evidence that people have episodes of greater or lesser gut leakiness based on the composition of their diets. "Certain foods, high fat foods, may promote the absorption of the toxin in your gut which could cause inflammation," Ward said. "Will a month of eating the milk fat globule membrane strengthen the gut against that sort of stress? That's what we hope to find out."

Ward is well aware that people's relationships with food are complicated. As a former chef who developed an interest food chemistry and nutrition and followed that interest right through graduate school and into a faculty position, Ward's goal is discovering more about the chemical and physiological changes that foods create. In the meantime, he recommends paying attention to what we eat without getting overzealous about any single component.

"We know some things and can look at our diets and say, 'Too much saturated fat is causing heart disease. Too much sodium causes high blood pressure and too much sugar causes high triglycerides,'" Ward said. "But people can get a little bit nuts about individual components of their diet instead of considering their whole diet. You get people who say they are going to reduce the amount of saturated fat in their diet, but then they increase the amount of gummy bears they eat because they don't have any saturated fat. That is really the wrong direction to go." –LH

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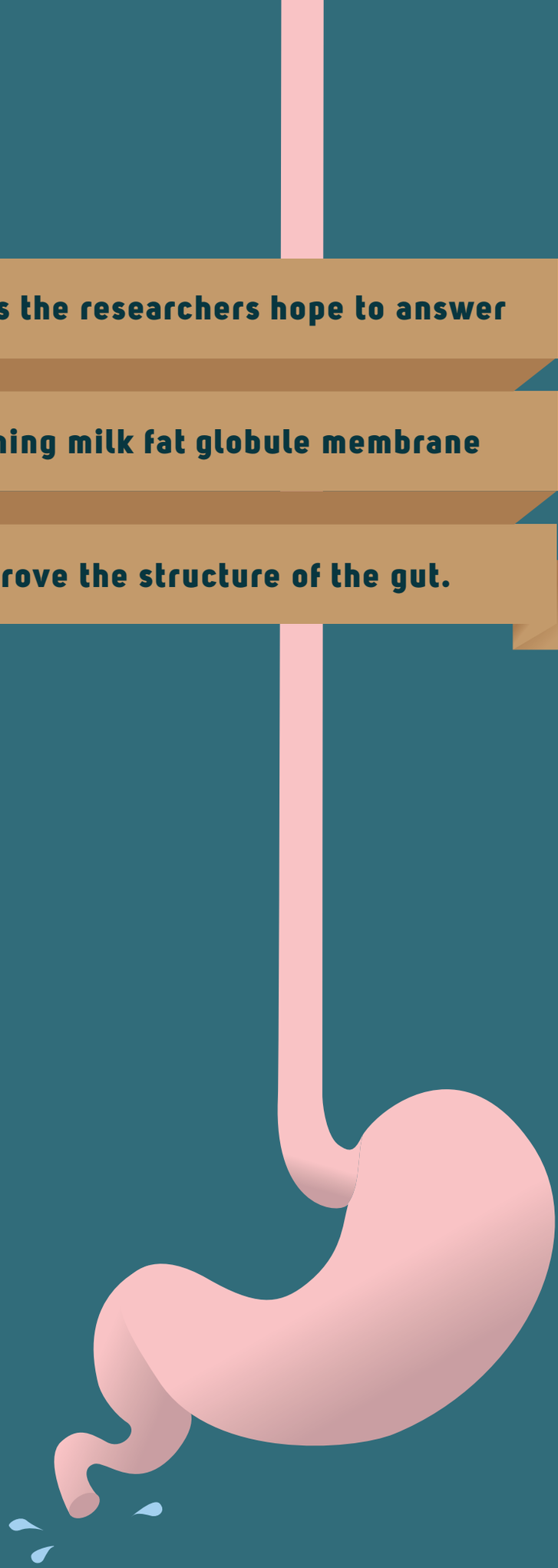
Among the questions the researchers hope to answer is whether consuming milk fat globule membrane (MFGM) can improve the structure of the gut.



EDUCATION

a Diabetes Predictor? Sociologist Finds a Link

Illustrations: Elizabeth Lord, 4D2A, All Free Downloads

Obesity and type 2 diabetes have long been known to be linked, said Eric Reither, an associate Professor in the Department of Sociology, Social Work and Anthropology at Utah State University. Reither, who has spent his career studying the physical and social effects of obesity, explained that nearly 80% of people with type 2 diabetes are either overweight or obese.With such serious potential health consequences, it is important to understand the determinants of obesity in America. Of course, it is known that diet and physical activity are linked to weight changes. However, some of Reither's research points to an underlying predictor of obesity and diabetes in Utah — educational attainment.

"Well-educated men and women exhibit lower rates of diabetes than those with less education," Reither explained. "The prevalence of diabetes is increasing in Utah…but these disparities have not changed appreciably over the past decade." Though many discrepancies in health can be described by the general term "socioeconomic status," which takes into account income, education, and occupation, Reither has found that education has important effects over and above the other factors.

Some of Reither's research points to an underlying predictor of obesity and diabetes in Utah : educational attainment.

The effects of education on type 2 diabetes rates are seen most strongly in adults with the least amount of formal education, like those who dropped out of high school. According to one of Reither's published studies, "The prevalence of diabetes among adults in Utah increased by 44% during the period of observation in this study (from 4.37% in 1996-1999 to 6.30% in 2004-2007). …The study also found that women with a college education were 27% less likely than women with a high school education to have diabetes."

"Education encourages behaviors that help people avoid obesity and related outcomes like type-2 diabetes," Reither said. "More educated individuals tend to have a better sense of what they need to do in terms of diet and physical activity. They are also more likely to get regular health screenings, and are more future oriented. All of those things put together tend to lead to better health outcomes, and that is true with diabetes as well." Reither hopes that this research will help spur the public health community and Utah policy makers to reach out to groups with educational disadvantages through health-based interventions.

Though rates of obesity seem to be growing at a slower pace today than in previous years, Reither said that people of all education levels must remain diligent about their health. "You have obesity working in

one direction and better treatments working in the other," he said. "It's part of what makes recent mortality trends worrisome among certain groups in the U.S. We see increases in mortality related to diabetes and cardiovascular disease, in spite of all of the wonderful medical progress that's taken place. That's one sobering indicator of how serious the obesity epidemic really is."

Although the prevalence of obesity in Utah is 10% lower than the national average of 35.7%, due in part to the state's culture of outdoor recreation and activity, Reither cautions that Utahn's waistlines may still have "room to grow" in the coming years if social policies and workplace standards do not change to support wiser health behaviors. "I think that people are increasingly aware that the choices they make regarding things like screen time and dietary choices add up to make a difference. However, it is equally important that social policies—things like school lunch programs and the subsidization of certain kinds of foods—catch up to our national health priorities. Employers should also recognize that providing opportunities for physical activity during the workday will encourage a healthier and more productive workforce that ultimately uses fewer health care resources." –ET

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Photo: Gary Neuenswander

Illustrations: Elizabeth Lord

Beyond the Baby Weight

Most expectant mothers know that how they take care of their body during pregnancy will affect the health of their newborn child. Now, new research suggests that some aspects of prenatal care, specifically maternal weight gain, may impact a child's health well into adolescence.

Using the Utah Population Database , Utah State University Associate Professor Eric Reither and his colleagues have been able to tease out links between timing of prenatal care and obesity rates among different ethnic groups in the state of Utah. The Utah Population Database is one of the most comprehensive population records in the nation, tracking information including timing of initial prenatal care, mother's and child's weights at time of birth, weight of a child upon receiving their driver's license, and ethnicity.

Reither's research divided information from the population database along ethnic lines for three groups: Native Hawaiian and other Pacific Islanders (NHOPI), Asians, and non-Hispanic Whites. The researchers decided to focus on these groups because their lifestyles, access to health care, and rates of disease vary greatly.

"Their socioeconomic characteristics tend to be different," said Reither. "So, for example, levels of education, levels of income tend to be different across those groups. Also, groups from mainland Asia in the U.S. have some of the lowest levels of obesity observed among any ethnic group. Conversely, Native Hawaiians and Pacific Islanders tend to have quite high levels of obesity and diabetes. A lot of research examines these groups as a single entity, obscuring their considerable differences."

A healthy pregnancy is the start of a healthy life.

Having such a large and diverse population sample allowed researchers to compare many variables. "We were interested in the effects that prenatal care could have in narrowing some pretty stark ethnic differences in obesity," said Reither. Among other important influences like mother's education and family structure, two major factors appear to influence a child's rate of obesity during their adolescent years: a mother's weight during pregnancy and her access to prenatal care.

"We suspect that timely prenatal care encourages mothers to adopt healthy behaviors early," said Reither. "Overweight women are more likely to have larger babies and are more likely to gain weight in excess of doctors' recommendations during pregnancy." In their article, Prenatal Care, Childhood Obesity, and Ethnic Health Disparities: Analyses from a Unique Population Database published in the Journal of Heath Care for the Poor and Underserved, the researchers suggested that the best way for overweight women to achieve optimal health outcomes for their babies was to gain a limited but healthy amount of weight during pregnancy.

As upward trends in obesity continue, teaching women about the risks of being obese during pregnancy may be more important than ever. According to the Utah Population Database, rates of obesity in expectant mothers were 4% among Asians, 9% among non-Hispanic Whites, and 14% among NHOPIs. Of course, an overweight mother does not guarantee that a child will become obese, leading the researchers to believe that something else about prenatal care plays a role in children's lives.

> "If expectant mothers can prevent obesity and other health complications during pregnancy, their offspring will have better chances for healthy lives down the road." — Eric Reither

Results from analyses of the population database suggest that children of obese women are far more likely to be obese during adolescence — especially if their mother did not receive prenatal care until after the first trimester. "Women who initiated prenatal care at an early stage of pregnancy were much less likely to have offspring who struggled with obesity in adolescence," Reither pointed out.

Timing appears to be key for pregnant women seeking prenatal care. Reduced adolescent obesity was only seen in mothers who visited doctors during their first trimester. Even women who received the same quality of care and visited the doctor the same number of times, but who waited to begin visits until later in their pregnancies were more likely to have children who were overweight during adolescence than women who initiated prenatal care early on.

What occurs in a mother's body during the first trimester is known to have a significant effect on the developing fetus. "If expectant mothers can prevent obesity and other health complications during pregnancy, their offspring will have better chances for healthy lives down the road," Reither said.

Although the genes that a child receives from their parents are fixed, the structure of the genes is not. Changes in structure can be caused by environmental factors which can turn individual genes on or off. These small changes in the genome — known as epigenetics — can have large effects throughout a person's lifetime. A woman's weight during her first trimester of pregnancy may change which genes are activated in her child, possibly increasing the child's risk for obesity later in life.

Reither suggests that changes in gene expression happen early in pregnancy, which is why healthy changes to a mother's diet have a bigger effect if they are implemented in the first trimester. "Doctors now will recommend early in pregnancy — and in fact, even before considering pregnancy — that women do certain things to improve their health," Reither said. "Actually, that both partners do certain things for a period of time to maximize potential health outcomes."

Although it doesn't appear that these epigenetic changes can be reversed with healthy lifestyle changes in later months of pregnancy, Reither does not want to dissuade mothers from making changes if they miss the first trimester window. "I think that if halfway through a pregnancy a woman realized that she could do a little better in terms of diet and exercise that, of course, is preferable to no changes in behavior," he said.

Rates of obesity can vary widely between ethnic groups. In Utah, NHOPI women were more likely than women of other ethnicities to be obese and were about 20% less likely to initiate prenatal care in their first trimester of pregnancy. This relationship between maternal obesity, high birth weight, and adolescent obesity is what Reither referred to as a "troubling intergenerational cycle" in his article.

"The idea is that after a few generations, both from an epigenetic standpoint and from a sociological standpoint, these things can become fairly entrenched," Reither said. For researchers trying to determine how to best break this intergenerational cycle, determining where changes need to be made can be difficult, as both social and genetic factors influence a person's weight. "You start looking for interventions — ways that you can break through cycles and you know there's no simple answer to that, no magic bullet, but it seems that early adoption of prenatal care could be one useful tool to help break these cycles of obesity among certain ethnic groups."

Reither and his colleagues hope that this study will encourage insurance companies and public health agencies to adopt programs that encourage all pregnant women to visit with their doctors as early as possible "The evidence suggests that early initiation of prenatal care really does help. Doctors are well positioned to encourage good nutrition, reasonable levels of physical activity, and appropriate weight gain to help women and their offspring avoid obesity and related health complications." –ET

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synthesis:

Undergraduate researchers from some of the state's universities showcased the breadth and significance of th
legislative session. Students are joined here by the presidents of their universities, including USU President Stan

eir work at the state capital's rotunda during the past
Albrecht (front row, far left).

Research on Capitol Hill

Undergraduate researchers from Utah State University gathered on Utah's Capitol Hill during the 2013 legislative session to present a diverse range of research to Utah's lawmakers. Students from various academic backgrounds met in the rotunda of the state capitol to display posters outlining their research. Many of the undergraduate researchers work with faculty mentors who conduct research through the Utah State University Agricultural Experiment Station. Some of their work is highlighted here.

"These students are USU's pride, representing the state's bright young minds that will eventually make significant contributions to the economy and knowledge-based workforce," said Utah State University President, Stan Albrecht.

Research on Capitol Hill is currently in its 13th year and was founded as a way for Utah's research universities to display the contributions that its undergraduate researchers and their faculty mentors make to the state of Utah.

"Student research offers benefits to students and faculty alike, but their contributions will also help prepare them for Utah's high-tech knowledge economy, and provide statewide human capital capacity," said Mark McLellan, Vice President for Research and Dean of the School Graduate Studies.

Among the students exhibiting their work at this year's Research on the Hill were (clockwise from top left) Kathleen Combs, Thomas Anderson, Whitney Morgan, Carly Ann Jugler and Jordan Goodman who are part of UAES-supported research projects.

Differences in Microbial Abundance and Composition between Aspen and Conifer Soils

Carly Ann Jugler and Helga Van Miegroet

Soils are made of several components that sustain the functions of an ecosystem. These functions include habitat, water storage, nutrient storage and cycling, and carbon sequestration. Components of soil that determine the quality with which the ecosystem can perform these functions are highly variable and can be influenced by a number of biotic and abiotic factors.

Soil organic matter, or soil organic carbon, is one of the primary characteristics that contribute to a soil's capacity to store atmospheric carbon dioxide. This storage ability may mitigate CO2's warming effects in the atmosphere.

Microbes play an important role in a soil's capacity for carbon storage. In the process of deriving a source of energy from the environment for themselves, microbes release enzymes that turn organic compounds in the soil into CO2, protein, and sugar. Consequently, the more carbon released by microbes in a certain system, the less stable the carbon in that system is, and the smaller the capacity for the system to act as a carbon sink, a place where carbon is stored. Jugler and Van Miegroet's research looks at the differences in microbial biomass and microbial carbon digestion in aspen and conifer soils, which can be used at in indication of carbon cycling in a system.

Funding for research has been provided by a USU Undergraduate Research & Creative Opportunities (URCO) grant and an Undergraduate Research Assistant grant in the College of Natural Resources.

Nanospecific Inhibition of Secondary Metabolism by the Soil Bacterium Pseudomonas Chlororaphis O6 to ZnO Nanoparticles

Jordan Goodman and Anne Anderson

Nanotechnology is revolutionizing imaging techniques, antibiotic therapy and cancer treatments. Nanoparticles are also used in many commercial products such as sunscreens, paints, ceramics, and semiconductors. Consequently, it is inevitable that nanoparticles (NPs) find their way into the environment.

Metaloxide NPs such as zinc oxide (ZnO) are toxic to many bacterial pathogens. However, many soil bacteria are beneficial to plant growth and the presence of nanoparticles at toxic levels could have serious consequences for plant development. The beneficial, root-colonizing bacteria Pseudomonas chlororaphis O6 (PcO6) has a high tolerance to ZnO nanoparticles. However, in sublethal doses, ZnO nanoparticles change the secondary metabolism of PcO6 in a way that could negatively impact agricultural systems. For instance, formation of the beneficial antibiotic phenazines produced by PcO6 is strongly inhibited in the presence of ZnO nanoparticles. The effects of nanoparticles on phenazines are important because the antibiotic alerts the plant to the presence of microbes and elicits a resistance response that is much like triggering the human immune system.

We are now investigating whether the sublethal ZnO treatment induces changes in the PcO6 cells that that make them resistant to other stresses, similar to how exposure of human pathogens to antibiotics can cause resistance to other antibiotics.

A New Approach to Creating Pradimicin-Type Antifungal/Antiviral Compounds

Thomas Anderson, Jon Takemoto, Jixun Zhang, Whitney Morgan

Pradimicin is a small molecule produced by the soil bacterium Actinomadura hibisica. It is active against a broad spectrum of opportunistic, pathogenic fungi, interferes with replication of the influenza virus, and inhibits the reproduction of HIV-I. Because of this, Actinomadura hibisica is a promising candidate as a combined antifungal/antiviral therapeutic.

The team's research focuses on determining the biosynthetic pathway of pradimicin in order to create chemical compounds with a similar structure that have high solubility and activity, and low toxicity. They intend to use the gene of one of the key enzymes in pradimicin synthesis, PdmS, to create new, more effective pradimicin analogs. Through experimenting, they determined that PdmS acts as a glycosyl transferase, and had the ability to create analogs of pradimicin with new sugar attachments. Knowledge of this enzyme provides a starting molecule for further structural modification to yield new chemical compounds for bioactivity studies.

Genetic Diversity in New, Hardy Kentucky Bluegrass Breeding Lines

Kathleen Margit Combs, Paul Johnson, Shaun Bushman

Kentucky bluegrass (Poa pratensis L.) is a commonly used turf grass species with many varieties sold worldwide. These varieties are structurally similar and hard to tell apart visually. The objective of the group's research is to use genetic markers (primers) to identify varieties. They will also use the data to explore the apomictic (clonal reproduction) tendency of the varieties. The researchers collected leaf tissue from 24 Kentucky bluegrass varieties, then collected and sequenced portions of the plants' DNA using 29 EST and 21 genomic primers. The data was used to determine genetic relationships between the plant types. They found high variability among the varieties. Each variety was unique and genetically distinguishable from one another; however, some varieties had high variability within a group. This was unexpected due to the usual apomictic nature of the species. This research is valuable to the turf grass industry for plant variety protection and the markers resulting from the research will be made available to the industry.

Photo by Gery Neuenswander

New Director for Experiment Station, College and USU Extension

Following an extensive, nationwide search, Utah State University has named professor and department head Kenneth L. White, to a three-part position that will make him dean of the College of Agriculture and Applied Sciences, vice president of Extension and director of the Utah Agricultural Experiment Station.

White is well respected both for teaching and research excellence throughout his career at USU. He currently is head of USU's Department of Animal, Dairy and Veterinary Sciences and associate dean of university's new School of Veterinary Medicine.

"We are all honored that Dr. White has accepted this assignment," said USU President Stan L. Albrecht. "These are three extremely critical positions at the university, and it is a rare individual who has the breadth of skills to accomplish all these tasks. We are lucky to have that exceptional individual already here on campus. Dr. White is a proven talent, and it gives me great pleasure to make this announcement."

White said he looks forward to the opportunity this appointment presents, and he thanked the president, the search committee and other faculty and staff for having confidence in him.

"We have excellent programs already in place and tremendous opportunities to grow those and other programs," White said. "I'm also excited to work with exceptional people — people I already know — both in the college itself and in the state. I recognize that I have huge shoes to fill, but the units are in extremely good health, and I look forward to the challenge."

White will replace Noelle Cockett, who steps down from the position to become USU's executive vice president and provost on July 1.

Search committee chair Mark McLellan, USU's vice president for research and dean of the School of Graduate Studies, said White was selected after the committee narrowed the list of finalists to three from among the more than 100 contacted. McLellan said the three-part job is a massive undertaking that requires skills to integrate the teaching, research and outreach missions of the university in a way that promotes acquiring new knowledge, training students and full commitment to translating research to the benefit of the citizens of this state, the nation and the world.

Cockett said White brings proven administrative skills to the new position, and she has no doubts that he will excel. "It's not just that he 'knows this place,'" Cockett said. "We are looking both at what's right for USU right now and where we want to go next, and I have complete confidence that Ken can lead us forward through those next challenges."

White came to USU in 1991 as an associate professor. He received his bachelor of science in animal science at Brigham Young University in 1979. He earned a master of science in animal science at University of California, Davis in 1982 and a Ph.D. in physiology (with an immunology minor) at University of California, Davis in 1986.

While at USU, White has been associate director of research at the Center for Integrated BioSystems, director of the Center for Developmental and Molecular Biology, and is currently interim director of the Center for Integrated BioSystems. Working with colleagues that University of Idaho, White and his research team did the embryo nuclear transfer that produced the world's first equine clone (and his two genetically identical brothers). As an independent researcher, he has generated more than $15 million in extramural funding in his career, nearly $11.5 million at USU. He has received or has pending five patents.

He has published more than 80 peer-reviewed scientific articles, and he also published six book chapters and 94 other scientific publications.

FOOD DUDES

School lunches have historically been about as well known for their nutritional value as children are for choosing broccoli and carrots over pizza in the lunch line. As the obesity epidemic in the United States spreads, the importance of children learning healthy eating habits while they are young has become increasingly evident. According to the Centers for Disease Control and Prevention, the rate of childhood obesity has more than doubled in the last 30 years, with 18% of children between the ages of 6-11 now considered obese. Teaching children how to make healthier choices regarding food has become a top priority for many researchers, including Heidi Wengreen, assistant professor in USU's Department of Nutrition, Dietetics, and Food Sciences.

Animations: RJDM

Wengreen, along with her colleagues, has been working on adapting the Food Dudes program, which was developed by researches in the United Kingdom, to the U.S. school system. Food Dudes is a school based intervention that's aimed at increasing kid's fruit and vegetable c onsumption," Wengreen said. "It basically incorporates the question of whether we can incentivize food behavior."

Food Dudes was introduced to selected schools in the Cache County School District between 2010 and 2012, results from the pilot study were published in the January—February issue of the Journal of Nutrition Education and Behavior. In the initial trials, which lasted 16 days, students were introduced to the program through what Wengreen describes as the three R's of Food Dudes: role modeling, repeated tasting, and rewards.

The Three R's

The role models for the Food Dudes intervention are teen-aged cartoon characters appropriately named the Food Dudes. "They like fruits and vegetables and they have special characteristics that are associated with that," said Wengreen. "They're athletic, and they're smart, and pretty.They are encouraging them to eat more fruits and vegetables," especially during lunch time, when the kids are given modified school lunches.

"In Food Dudes there are four combinations of fruits and vegetables tha the kids kind of rotate through during the 16 day period," said Wengreen, "We don't necessarily target fruits and vegetables that the kids wouldn't recognize or hadn't tasted before. The theory is it doesn't matter what fruit and vegetable combinations you pick, it's just trying to incentivize the behavior of getting kids to regularly consume those fruits and vegetables and that that behavior should translate over to other fruits and vegetables."

If increasing children's consumption of fruits and vegetables were as easy as introducing the kids to new forms of roughage, Food Dudes probably wouldn't be needed in U.S. schools. Unfortunately, giving children access to healthier foods doesn't mean that they will eat them. The third "R" of Wengreen's approach, rewards, hopes to overcome many children's aversion to fruits and vegetables by incentivizing healthy eating.

Depending on the school in the program, students were incentivized in different ways. Those who met personal goals for fruit and vegetable consumption were rewarded with either tangible rewards like Frisbees and bouncy balls or were given praise and recognition from teachers and fellow students. Through the study, Wengreen discovered that praise was not enough of an incentive to get students to significantly change their diets.

Methods

It wasn't until the students were actually faced with making good food choices in the cafeteria that Wengreen and her colleagues were able to see if the presence of role models and rewards would be enough to change behavior. Recording the children's eating habits was not a simple task. After the children picked out their food and before they had a chance to start nibbling on it, a researcher snapped a picture of their tray in a process that Wengreen called "digital observation". "It's pretty laborious, it's a more detailed method than a lot of people use," said Wengreen, "We have observers in the cafeteria that are monitoring the kids so they don't do funky things like hide their peas in milk cartons. We try to help them understand that it is important not to swap food." After the children finished eating, another picture was taken. The resulting before and after shots—some 55,000 of them—were analyzed by trained observers whose job it was to estimate the amounts of fruits and vegetables eaten.

Initially, the program seemed to be working. At one school, consumption of fruits and vegetables almost doubled over the 16-day trial period. "That was when we were incentivizing their behavior," explained Wengreen. "So, of course, you would expect intake would go up...But after we removed the incentives, the kids basically went back to what they were doing in the beginning, so the behavior wasn't maintained." Wengreen thinks that a combination of factors may have contributed to the children's loss of interest in fruits and vegetables after the experimental period ended. In theory, the Food Dudes program should help children make associations between healthy food and rewards. After children get in the habit of eating their fruits and vegetables the rewards are slowly taken away, leaving behind the positive behavior. "We feel like we needed a longer period of time to be able to incentivize the kids and for them to be able to change their behavior," Wengreen said.

Maintaining incentives for students who continued to eat fruits and vegetables after the initial trial period was difficult as well, especially since this portion of the program was left up to teachers once the researchers left. "Teachers are already so pressed for time, and that time during class is so valuable because teachers have to teach the

Lunches: Before & After

These are just a few of the some 55,000 photos Heidi Wengreen and her assistants took of lunch trays at schools in the study. Each tray was labeled with its own numeric code that allowed researchers to do quantifiable comparisons of what each child consumed.

Photos: Courtesy of Heidi Wengreen

"Despite the health benefits of eating fruits and vegetables, less than 20% of children between the ages of 4-13 years are consuming the recommended 5 or more daily servings."

— "Incentivizing Children's Fruit and Vegetable Consumption: Results of a United States Pilot Study of the Food Dudes Program," Wengreen and co-authors, "Journal of Nutrition Education and Behavior"

pictures of what they eat at home." However, Wengreen hopes to introduce a new measurement method called Raman spectroscopy that can more accurately gather data on students' total fruit and vegetable consumption.

A Raman spectroscopy device can be used to measure carotenoids, which are fat-soluble pigments found in fruits and vegetables. "They get deposited in your body, including in your skin. So, the thought is that if we can measure skin carotenoids that should be a marker of fruit and vegetable intake," Wengreen said. "The kids put the palm of their hand up against the reader, it shines an infrared light on their palm, and it takes about 90 seconds to read. It's pretty quick, it's non-invasive, and they kind of think it's novel and cool." By measuring both a child's skin carotenoid levels and what they are eating during school lunch, researchers will be able to get a more complete idea of what school-aged children eat. Another benefit of this method is that Raman spectroscopy measurements are more objective than consumption estimates from photographs.

The Food Dudes program was reintroduced to select Cache County schools this spring. Wengreen hopes that the structural changes increase fruit and vegetable consumption in students and work more smoothly within the U.S. school system. "It was too big a burden for schools, and that's not the message we want to give them…we want schools to be excited about it and kids to be excited." In the future, Wengreen hopes to see programs similar to Food Dudes that can be maintained within schools without research support, "We're trying to find a way that we can make that more sustainable and a little bit more enticing for schools to want to do it."

Wengreen hopes that the planned changes to the Food Dudes program will lead to long lasting changes in children's eating habits, or at least help children develop a taste for foods they might not otherwise try. Presenting fruits and vegetables to children when they are young, either at home or through programs like Food Dudes, is the best way to create a foundation for healthy eating for the rest of their lives. –ET

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ROCCO TOM CHARLIE RAZZ

search: Science on the web

Find Utah Science and other information about the people and projects of the Utah Agricultural Experiment Station online at uaes.usu.edu

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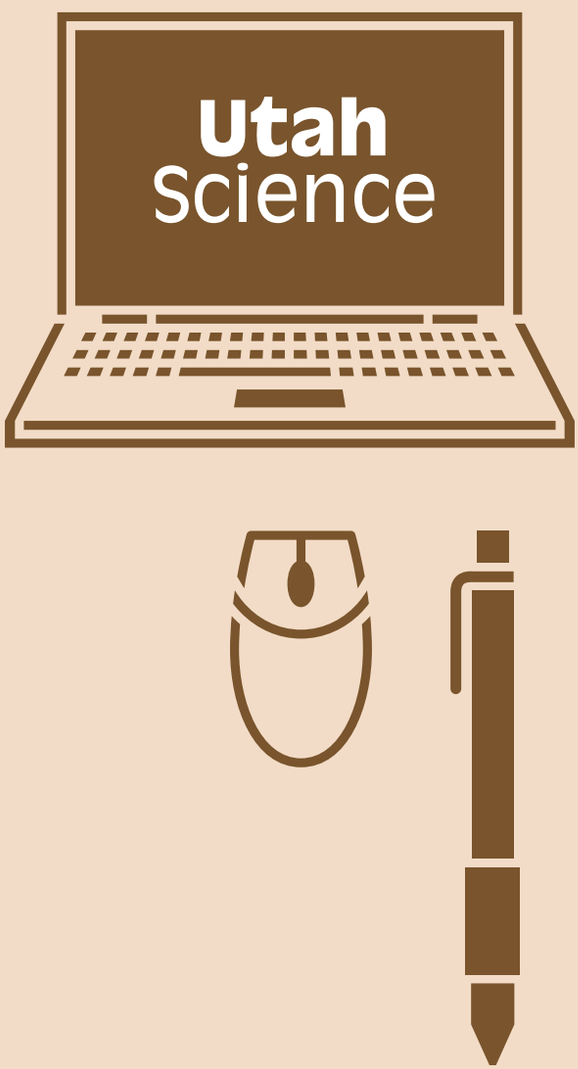

Illustration: 4D2A

CLEFT LIP AND CLEFT PALATE

http://www.nytimes.com/1998/04/26/magazine/the-clues-are-in-the-blood.html
In 1998, the New York Times sent writer Lisa Belkin to the Philippines for a story about Ron Munger's work among people with cleft lips and cleft palates. The feature story is on the New York Times' website.

http://www.nlm.nih.gov/medlineplus/cleftlipandpalate.html
Extensive Information about cleft lip and palate from the National Institutes of Health.

SOCIOLOGICAL FACTORS IN OBESITY AND TYPE 2 DIABETES

http://digitalcommons.usu.edu/sswa_facpubs/180/
Associations between Educational Attainment and Diabetes in Utah: The Behavioral Risk Factor Surveillance System, 1996-2007.

http://www.matheson.utah.edu/UHReview/
2009 Utah's Health: An Annual Review.

FOOD DUDES

www.fooddudes.co.uk
The official website of the Food Dudes.

http://www.choosemyplate.gov/kids/
Nutrition activities and more at the My Plate Kids' Place, from the U.S. Department of Agriculture.

The UAES offers these recommendations as a service to readers, but is not responsible for the content of sites it does not produce.

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